Machine Learning Algorithms for Urban Land Use Planning: A Review

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Abstract

Urbanization is persistent globally and has increasingly significant spatial and environmental consequences. It is especially challenging in developing countries due to the increasing pressure on the limited resources, and damage to the bio-physical environment. Traditional analytical methods of studying the urban land use dynamics associated with urbanization are static and tend to rely on top-down approaches, such as linear and mathematical modeling. These traditional approaches do not capture the nonlinear properties of land use change. New technologies, such as artificial intelligence (AI) and machine learning (ML) have made it possible to model and predict the nonlinear aspects of urban land dynamics. AI and ML are programmed to recognize patterns and carry out predictions, decision making and perform operations with speed and accuracy. Classification, analysis and modeling using earth observation-based data forms the basis for the geospatial support for land use planning. In the process of achieving higher accuracies in the classification of spatial data, ML algorithms are being developed and being improved to enhance the decision-making process. The purpose of the research is to bring out the various ML algorithms and statistical models that have been applied to study aspects of land use planning using earth observation-based data (EO). It intends to review their performance, functional requirements, interoperability requirements and for which research problems can they be applied best. The literature review revealed that random forest (RF), deep learning like convolutional neural network (CNN) and support vector machine (SVM) algorithms are best suited for classification and pattern analysis of earth observation-based data. GANs (generative adversarial networks) have been used to simulate urban patterns. Algorithms like cellular automata, spatial logistic regression and agent-based modeling have been used for studying urban growth, land use change and settlement pattern analysis. Most of the papers reviewed applied ML algorithms for classification of EO data and to study urban growth and land use change. It is observed that hybrid approaches have better performance in terms of accuracies, efficiency and computational cost.